Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Cloud Radar System (CRS) IPHEx

Introduction

The GPM Ground Validation Cloud Radar System (CRS) IPHEx data were collected in support of the Global Precipitation Measurement (GPM) mission Integrated Precipitation and Hydrology Experiment (IPHEx) in North Carolina, with an intense study period occurring from May 1, 2014 through June 15, 2014. The goal of IPHEx was to evaluate the accuracy of satellite precipitation measurements and use the collected data for hydrology models in the region. The ER-2 aircraft flew during the IPHEx field campaign to aid in GPM validation. The science instruments, including the CRS, onboard the aircraft acted as a proxy for GPM satellite instruments. The CRS provided high-resolution profiles of reflectivity and Doppler velocity in clouds at aircraft nadir along the flight track. The CRS data are available from May 3, 2014 through June 12, 2014 and files for this dataset are available in netCDF-3 format.

Notice: This dataset is defined as Version 2 by the PI, however, Version 1 and Version 2 of the dataset are identical. This just refers to a metadata recording change.

Citation

Heymsfield, Gerald M. and Lin Tian. 2015. GPM Ground Validation Cloud Radar System (CRS) IPHEx [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi:http://dx.doi.org/10.5067/GPMGV/IPHEX/CRS/DATA101

Keywords

NASA, GHRC, PMM, GPM GV, IPHEx, CRS, North Carolina, aircraft observations, ER-2, cloud radar system, W-Band Doppler radar, polarimetric, reflectivity, Doppler velocity

Campaign

The Global Precipitation Measurement mission Ground Validation (GPM GV) campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after launch of the GPM Core Satellite, which launched on February 27, 2014. The instrument validation effort included numerous GPM-specific and joint agency/international external field campaigns, using state of the art cloud and precipitation observational infrastructure (polarimetric radars, profilers, rain gauges, and disdrometers). These field campaigns accounted for the majority of the effort and resources expended by GPM GV mission. More information about the GPM GV mission is available at the PMM Ground Validation webpage.

One of the GPM Ground Validation field campaigns was the Integrated Precipitation and Hydrology Experiment (IPHEx) which was held in North Carolina during 2013 and 2014 with an intense study period from May 1 to June 15, 2014. The goal of IPHEx was to characterize warm season orographic precipitation regimes and the relationship between precipitation regimes and hydrologic processes in regions of complex terrain. The IPHEx campaign was part of the development, evaluation, and improvement of remote-sensing precipitation algorithms in support of the GPM mission through NASA GPM Ground Validation field campaign (IPHEX_GVFC) and the evaluation of Quantitative Precipitation Estimation (QPE) products for hydrologic forecasting and water resource applications in the Upper Tennessee, Catawba-Santee, Yadkin-Pee Dee, and Savannah river basins (IPHEX-HAP, H4SE). NOAA Hydrometeorology Testbed (HTM) has synergy with this project. More information about IPHEx is available at the IPHEx Field Campaign webpage.

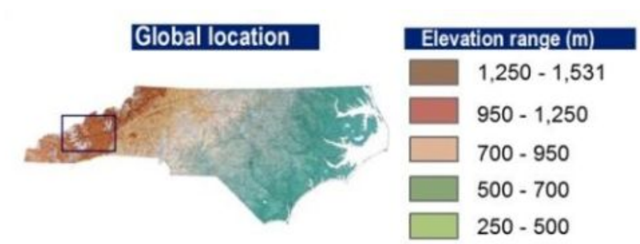

Figure 1: Region of North Carolina IPHEx campaign ground validation
(Image source: http://gpm-gv.gsfc.nasa.gov/Gauge/)

Instrument Description

The Cloud Radar System (CRS) is a 94 GHz, W-band Doppler radar at a 3 millimeter wavelength that was developed for autonomous operation on the NASA Earth Resources 2 (ER-2) high-altitude science aircraft. CRS can also be used for ground-based operations. CRS provides high-resolution profiles of reflectivity and Doppler velocity in clouds and has important applications to atmospheric remote sensing studies. The CRS was designed to be used with the Cloud LiDAR System (CLS) in the tailcone of the ER-2 superpod (Figure 3). There are two basic modes of operation of the CRS: (1) ER-2 mode, which collects reflectivity, Doppler, and linear-depolarization measurements and (2) ground-based mode, which has full polarimetric capability. The ER-2 mode was used during the IPHEx field campaign and collected high-resolution profiles of reflectivity and Doppler velocity at aircraft nadir. Specifications of the CRS radar instrument are outlined in Table 1.

Table 1: Instrument Characteristics

Characteristic	Value
Frequency	94.155 GHz
Instrument	Cloud Radar System utilizing a 94.155 GHz W-band 3mm airborne Doppler radar
Transmitter Type	Extended Interaction Amplifier (EIA)
Peak Power	1.7 kW(kilowatts)
Beamwidth	0.4 degrees
Pulse Repetition Frequency	0.5 - 20 kHz
Range Resolution	150 meters at 10km range
Gate Spacing	37.5 meters

For more information about the NASA ER-2 CRS, refer to the NASA Airborne Science Program CRS webpage and Li et al., 2004, describing the radar system in detail.

Figure 2: CRS setup in laboratory with the airborne antenna configuration (Image Source: Li et al., 2004)

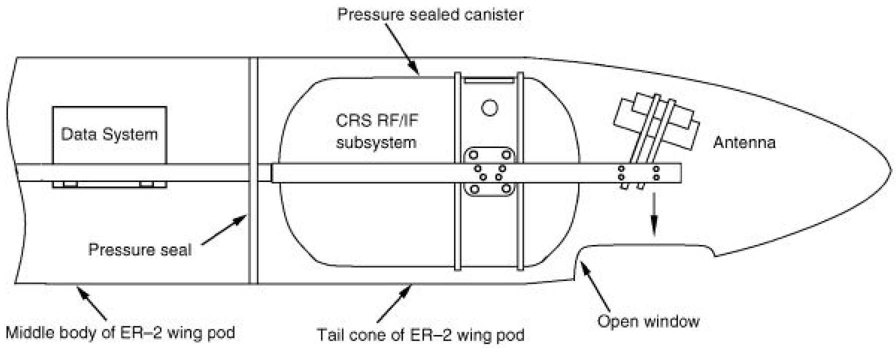

Figure 3: CRS configuration with airborne antenna in the tailcone of the ER-2 superpod.
(Image Source: Li et al., 2004)

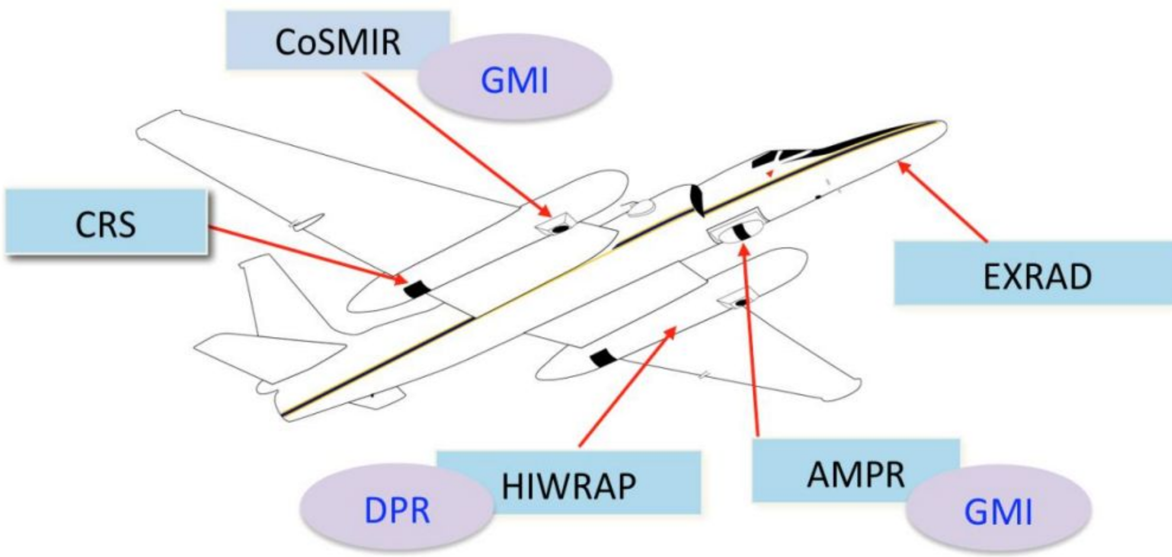

Figure 4: The CRS was located on the underside of the right wing of the NASA ER-2 aircraft. The blue boxes label the instruments onboard, and the purple circles indicate which GPM Satellite instrument they simulated.
(Image source: IPHEx Science Plan)

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Data Characteristics

The GPM Ground Validation Cloud Radar System (CRS) IPHEx radar data files contain radar reflectivity and Doppler velocity measurements from CRS and are available in netCDF-3 file format at Level 1B processing level. More information about the NASA data processing levels are available on the EOSDIS Data Processing Levels webpage. Table 2 outlines key CRS IPHEx dataset characteristics.

Table 2: Data Characteristics

Characteristic	Description
Platform	NASA Earth Resources 2 (ER-2) aircraft
Instrument	Cloud Radar System (CRS)
Spatial Coverage	N: 46.7, S:34.5, E:-81, W:-83.09 (North Carolina)
Spatial Resolution	150m footprint at 20 km altitude
Temporal Coverage	May 3, 2014 - June 12, 2014
Temporal Resolution	Hourly - < Daily
Sampling Frequency	1 Minute - < 1 hour
Parameter	Radar reflectivity, Doppler velocity
Version	2
Processing Level	1B

File Naming Convention

The IPHEx Cloud Radar System (CRS) dataset files are named with the following convention:

Data files: IPHEX_CRS_L1B_<start time>_<end time>_dist_v02.nc

Table 3: File naming convention variables

Variable	Description
<start_time>_<end_time>	Start and end time of the flight as YYYYMMDD-hhmmss in UTC, where: YYYY = four-digit year MM = two-digit month DD = two-digit day hh = two-digit hour in UTC mm = two-digit minute in UTC ss = two-digit second in UTC
v02	Version 2
.nc	netCDF-3 file type

Data Format and Parameters

The GPM Ground Validation Cloud Radar System (CRS) IPHEx radar dataset contains radar reflectivity and Doppler velocity measurements collected during flight by the radar while mounted on the NASA ER-2 high altitude science aircraft. Each data file also contains flight information such as aircraft altitude, orientation, and GPS location. The Doppler velocity field values (doppcorr) are CRS Doppler velocity measurements after correction for the motion and orientation of the aircraft. Table 4 provides descriptions for each data field.

Table 4: Data Fields

Field Name	Description	Data Type	Unit
Altitude	Aircraft Altitude	float	meter
dopcorr	CRS Doppler velocity after correct for aircraft motion and folding	float	m/s
evel	East aircraft ground speed	float	m/s
gatesp	Radar range gate	float	m
gspeed	Aircraft ground speed	float	m/s
head	Aircraft heading	float	degree
lat	GPS aircraft latitude, minus sign = South	float	degree
lon	GPS aircraft longitude, minus sign = West	float	degree
missing	Missing value	float	-
noise_thresh	Noise threshold	float	-
nvel	North aircraft ground speed	float	m/s
pitch	Aircraft pitch angle	float	degree
range	Range from radar	float	m
roll	Aircraft roll angle	float	degree
sigm0	Surface sigma0	float	dB
tilt	Incidence Angle	float	degree
timed	UTC time	float	hour
track	Aircraft track angle	float	degree
vacft	Estimate of aircraft Doppler component	float	m/s
wlku	Wavelength length of radar	float	m
wvel	Aircraft vertical speed	float	m/s
year	Year the data was collected	short	-
zku	CRS Radar Reflectivity	float	dBZ

Algorithm

The CRS data processing system uses dual pulse repetition frequencies to obtain clear, definitive Doppler velocity measurements. The Doppler processing was done using the pulse pair estimation method, which requires less computation that other methods. This method is often used in pulse Doppler radar signal processing. The mean Doppler and spectrum width are calculated in post-processing. More detail on how the CRS data was obtained can be found in Li et al. (2004).

Quality Assessment

Both internal and external calibration methods are used on the GPM Ground Validation CRS. Radar calibration helps to minimize erroneous reflectivity measurements. Internal calibration of the CRS included monitoring receiver performance and transmitter stability. External calibration was done by using target calibration methods and intercomparing CRS measurements with those of other radars. Also, CRS Doppler velocity values have been corrected for the motion and orientation of the aircraft. More information about the ER-2 CRS calibration methods can be found in Li et al., 2004.

Software

This dataset is in netCDF-3 format and does not require any specific software to read. However, Panoply is an easy-to-use free tool for reading and visualizing the data within the netCDF-3 files.

Known Issues or Missing Data

There are some instances of missing data caused by instrument issues during the IPHEx CRS flights. All instances of missing data are flagged in the data files under the "missing" field name. Additional details can be found the in GHRC directory for IPHEx CRS instrument reports.

References

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Related Data

All data from other instruments collected during the IPHEx field campaign are related to this dataset. The following datasets are from the other instruments flown onboard the ER-2 during the campaign. The full list of IPHEx campaign data can be located using the GHRC HyDRO 2.0 search tool and searching 'IPHEx'. The complete IPHEx Field Campaign data collection can be found here.

GPM Ground Validation Conical Scanning Millimeter-wave Imaging Radiometer (CoSMIR) IPHEx
(http://dx.doi.org/10.5067/GPMGV/IPHEX/CoSMIR/DATA101)

GPM Ground Validation ER-2 X-band Radar (EXRAD) IPHEx
(http://dx.doi.org/10.5067/GPMGV/IPHEX/EXRAD/DATA101)

GPM Ground Validation High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) IPHEx
(http://dx.doi.org/10.5067/GPMGV/IPHEX/HIWRAP/DATA101)

GPM Ground Validation Advanced Microwave Precipitation Radiometer (AMPR) IPHEx

(http://dx.doi.org/10.5067/GPMGV/IPHEX/AMPR/DATA202)

GPM Ground Validation NASA ER-2 Navigation Data IPHEx
(http://dx.doi.org/10.5067/GPMGV/IPHEX/NAV/DATA002)

Datasets from other field campaigns that used the CRS instrument to collect data can be found by searching 'CRS' in HyDRO 2.0.

Contact Information

To order these data or for further information, please contact:

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